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The Lateral Scapular Slide Test: Is It Valid in Detecting Glenohumeral Impingement Syndrome?

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THE LATERAL SCAPULAR SLIDE TEST: IS IT VALID IN DETECTING

GLENOHUMERAL IMPINGEMENT SYNDROME?

by

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This Independent Study, submitted by Denise G. Litchfield in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physcial Therapy under whom the work has been done and is hereby approved.

Susan H. Jeno
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Thomas Mohr
(Chairperson, Physical Therapy)

PERMISSION

Title	The Lateral Scapular Slide Test: Is it Valid in Detecting Glenohumeral Impingement Syndrome?
Department	Physical Therapy
Degree	Master of Physical Therapy

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Signature Denise G. Kitchfield

Date 12/10/95

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ABSTRACT

Recent literature has focused on instability of the scapulothoracic joint and on resulting scapular positions. Weakness of the scapular musculature can allow the scapula to slide laterally, leading to abnormal glenohumeral biomechanics and to subsequent shoulder pathology. Kibler[1] has described the lateral scapular slide test (LSST) as a method of measuring lateral translation of the scapula. A significant difference between right and left scapular positions, as indicated by a discrepancy of greater than one centimeter side-to-side, may indicate functional scapulothoracic instability. The purpose of this study was to evaluate validity of the LSST, measured in two positions. Modified LSST measurements of asymptomatic subjects were compared to measurements of subjects with unilateral glenohumeral impingement. A t-test for independent samples revealed a significant difference between the subject groups in position 1 ($p < .05$) but not in position 2 ($p < .05$). Results suggest that position 1 of the LSST may be utilized to assess scapulothoracic abnormalities in persons with glenohumeral impingement.

CHAPTER I

INTRODUCTION

Much attention in literature has focused on glenohumeral pathology and treatment. Recent interest has broadened to include examination of the entire shoulder girdle in the diagnosis and treatment of glenohumeral dysfunction. Specifically, research is now examining scapulothoracic weakness and subsequent abnormal scapular positions which may affect the glenohumeral joint. It has been demonstrated that most shoulder disorders contain an element of abnormal scapular movement and position, and muscle imbalance and/or weakness.[1] Alterations of joint position, muscle balance, and/or muscle strength within the body's kinetic chain can have a marked effect on biomechanics of other segments in this chain. A single alteration of the chain may cause dysfunction and/or pain anywhere in the chain. This phenomena occurs at the shoulder complex when weakness in the scapula musculature alters scapular position.[1-6] A change in scapular position affects the glenohumeral joint and may lead to impingement.[1,2,4,5,7-9]

Proper rehabilitation of shoulder impingement requires recognizing the source of impingement. There are many factors which can contribute to impingement, including spur formation, glenohumeral subluxation, and scapular instability. It is therefore necessary to screen for and differentiate between scapular instability and other causes. Thus, there is great need for a clinically-feasible assessment tool which can be utilized to detect scapular pathomechanics. This study will introduce an assessment tool, a modified lateral scapular slide test, and investigate its validity in predicting glenohumeral impingement.

CHAPTER II

LITERATURE REVIEW

Impingement and Anatomy of the Glenohumeral Joint

Glenohumeral impingement occurs due to entrapment of soft tissues in the subacromial space. Soft tissues, including the long head of the biceps tendon, the rotator cuff tendons, and/or the subacromial bursa, are impinged between the humeral head and its overlying structures.[4,10] Muscles which comprise the rotator cuff are the supraspinatus, infraspinatus, teres minor, and subscapularis. The tendons of these muscles blend with the glenohumeral capsule, pass through the subacromial space, and insert onto the greater and lesser tuberosities of the humerus. The long head of the biceps tendon enters the subacromial space between the subscapularis and supraspinatus tendons, passes through the joint capsule, and attaches to the superior aspect of the glenoid fossa. The coracoacromial arch is comprised of the coracoid and acromion processes and the connecting coracoacromial ligament. Between these tendons and the overlying coracoacromial arch lies the subacromial-subdeltoid bursa. Impingement of the aforementioned tendons and bursa occurs when the subacromial space becomes crowded by abnormal bony structures or by inflammed tissues.

Anatomy and Biomechanics of the Shoulder Girdle

The shoulder complex has a range of motion which exceeds that of any other joint structure in the body. Full and pain-free mobility of the shoulder depends on the smooth, coordinated effort of all involved structures. These structures include three bones: the scapula, the humerus, and the clavicle, and five joints: the acromioclavicular, glenohumeral, sternoclavicular, scapulothoracic, and subacromial joints. The scapula, oriented 30 to 45 degrees anterior to the frontal plane,[5,11] is capable of two translatory and three rotational movements. These include: elevation/depression, protraction/retraction, upward/downward rotation, rotation about a vertical axis (winging), and rotation about a coronal axis (tilting). Full shoulder elevation of 180 degrees requires approximately 120 degrees of glenohumeral elevation and 60 degrees of scapular rotation. Upward scapular rotation, which requires movement at both the sternoclavicular and acromioclavicular joints, tilts the glenoid fossa upward. This tilt provides a congruent glenoid base for the humeral head,[7] forming the glenohumeral articulation.

It is a well-known fact that proximal stability is necessary for proper distal mobility.[1,9] As the scapula has no bony or ligamentous attachments to the axial skeleton, position and stability of the scapulothoracic joint is solely dependent upon strength of the surrounding musculature. The scapula is a supporting structure to which 17 muscles attach. The primary muscles which anchor the scapula to the trunk include the rhomboideus major and minor, upper and lower trapezii, and serratus anterior.[2,9] All of these muscles, with exception of the serratus anterior, function to stabilize the medial scapular border in the scapular plane. The upper and lower trapezii, assisted by the levator scapula, also function to elevate the acromion process by upwardly rotating the scapula.[9] The serratus anterior stabilizes the medial scapular border in the transverse plane, primarily during humeral elevation. It also functions to upwardly rotate and protract the scapula. The muscles which contribute to scapulothoracic stability provide a strong structural base which is necessary for normal glenohumeral movement.[1,9,12]

Weakness in any of the scapular stabilizers may lead to altered scapular position.[2-5] Loss of strength in the trapezii, rhomboids, or levator scapula may contribute to lateral movement of the scapula, and will also limit scapular retraction.[4] Weakness of the serratus anterior leads to scapular "winging," or posterior rotation of the medial scapular border away from the thorax.

Glenohumeral Joint Biomechanical Alterations

An alteration of scapular position, specifically lateral scapular translation, will interfere with glenohumeral biomechanics and may subsequently result in pathology such as impingement. Three biomechanical alterations which can occur include: 1) an incongruent glenohumeral articulation,[2,4,13] 2) insufficient elevation of the acromion,[2,8] and/or 3) a compromise in normal muscle function.[2,11,13,14] There is a strong correlation between these three biomechanical alterations and glenohumeral impingement syndromes.[2,4,8]

The first biomechanical alteration is an incongruent articulation between the glenoid fossa and the humeral head. Glenohumeral congruency is achieved when glenoid movement follows humeral movement, and is necessary for two reasons. First, congruency provides a consistent instantaneous center of rotation throughout extremes of shoulder motion.[2,7,13] An instantaneous center of rotation which is not consistent throughout shoulder movement will cause an imbalance of motion and loss of stability at the glenohumeral joint.[15] Secondly, glenohumeral congruency, which is partially dependent on scapular position, is necessary to prevent additional stress on glenohumeral structures. The scapula may assume a more lateral position if the scapular base is unstable due to weakness. The glenoid fossa subsequently assumes a position of excessive anterior tilt. This tilt causes an abnormal widening of the anterior portion of the glenohumeral joint and allows the humeral head to migrate anteriorly.[2] In this position the humeral head will cause additional stress on anterior shoulder structures and can contribute to impingement problems.[2,9]

The second biomechanical alteration is insufficient elevation of the acromion. Normal elevation of the acromion, achieved primarily through action of the trapezius and serratus anterior,[2,12] allows the acromion to ascend and rotate correspondingly with the greater tuberosity of the humerus. If the serratus and trapezius muscles are unable to upwardly rotate the scapula during humeral elevation, structures in the subacromial space will become impinged as the greater tuberosity of the humerus approaches the acromion.

A third biomechanical alteration which results from an unstable scapular base is a compromise of normal muscle function. Scapulothoracic weakness causing an unstable scapula may lead to diminished strength in glenohumeral musculature by altering stability/mobility patterns.[2] Kibler[2] suggests that a hypermobile scapula may reverse the origins and insertions of glenohumeral muscles. Glenohumeral muscle fibers which are more stable at their distal insertion than at their scapular origin have a decreased capacity to generate force. Therefore, an unstable scapular base decreases ability of the glenohumeral muscles to contract and function properly.

A stable scapular base is also necessary to maintain a maximal length-tension ratio for efficient contraction of muscles acting on the glenohumeral joint, specifically the rotator cuff muscles.[2,13] As the scapula translates laterally, rotator cuff muscle fiber length is altered, decreasing the muscle length-tension ratio.[2,15] The length-tension ratio is a primary factor in the amount of torque generated at the glenohumeral joint.[16] A decrease in this ratio places the rotator cuff muscles at a mechanical disadvantage and diminishes muscle efficiency. According to Kendall and McCreary,[6] "stretch weakness" or "adaptive shortness" of muscles occurs as a result of faulty joint position. Kibler[2] postulates that as the scapula laterally deviates, scapulohumeral muscle fibers shorten. However, Ayub[17] and Cailliet[15] suggest that as the scapula translates laterally, the humerus internally rotates to maintain its congruency with the glenoid fossa. This rotation results in lengthened external rotators and shortened internal rotators.[15] In either case, the amount of force muscles are able to generate diminishes as the length-tension ratio of muscle fibers decreases.

Mechanical disadvantage imposed upon muscles which control humeral movement, specifically the rotator cuff musculature, places the shoulder at risk for impingement.[2,11,13,14] A rotator cuff which is weak due to altered muscle fiber length is less able to externally rotate, downwardly glide, and compress the humeral head in the glenoid fossa during arm elevation.[2,13] The normal force couple created by the rotator cuff and deltoid muscles functions in synchrony to elevate the arm (Fig 1). Rotator cuff weakness causes an imbalance in this force couple. Impingement results when the unopposed deltoid pulls the humeral head superiorly and anteriorly into the coracoacromial arch during arm elevation.[5,11,16] Rotator cuff weakness which leads to either delayed or decreased external rotation also predisposes the shoulder to impingement. Without full external rotation, the greater tuberosity of the humerus is unable to clear the acromion as the arm elevates,[11]causing impingement of structures in the subacromial space.

Scapulothoracic Weakness and Glenohumeral Impingement

Previous research has demonstrated a correlation between scapular muscle dysfunction and glenohumeral impingement.[2,8] Using Moire topographic analysis, a method of assessing three-dimensional shape of the body, Warner et al[8] developed a method to evaluate both the static and dynamic symmetry of the axioscapular muscles. Static analysis results revealed increased topography,

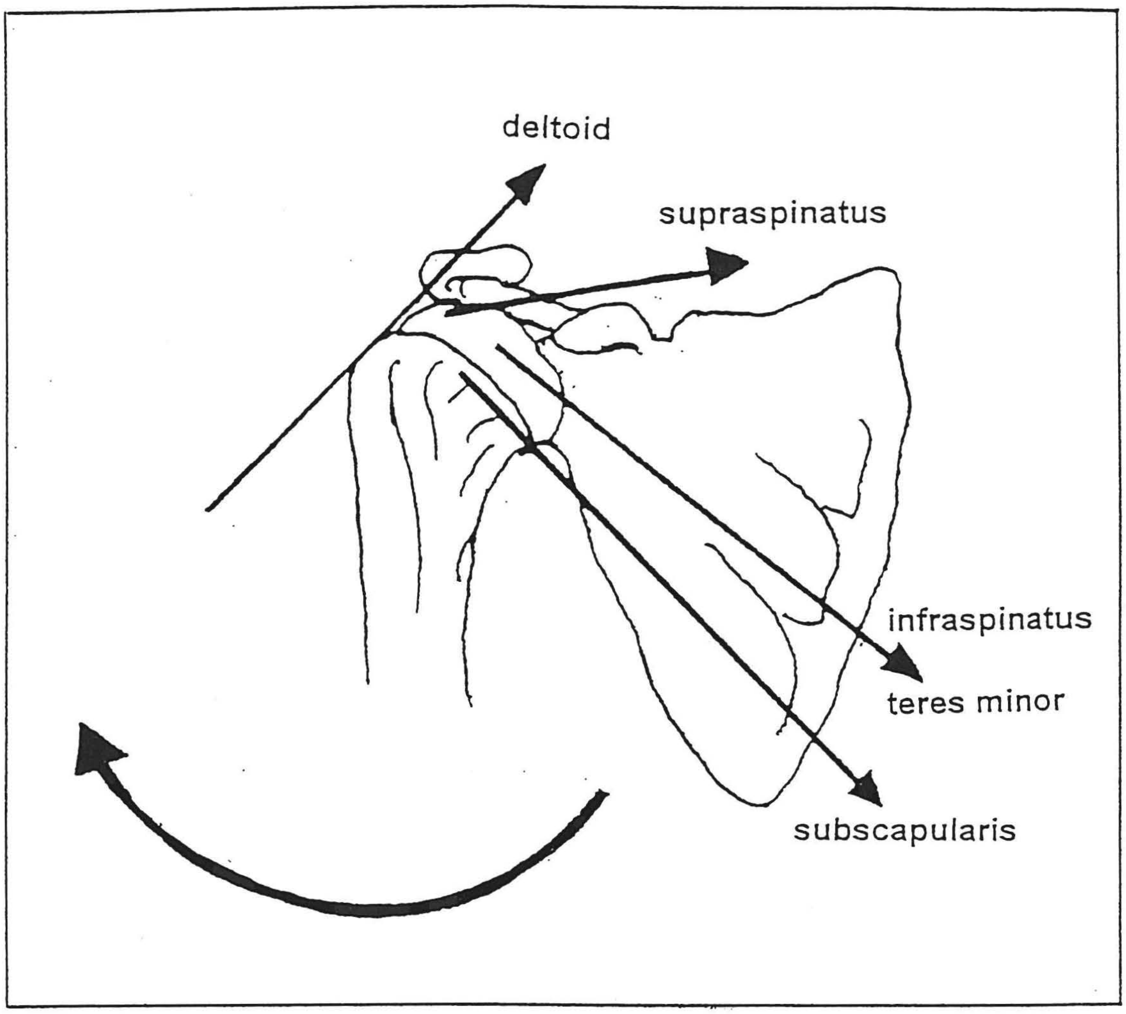

Fig 1.-- Normal force couple of the deltoid and rotator cuff.

indicating scapulothoracic asymmetry, in 57% of individuals with shoulder impingement as compared to only 14% in asymptomatic subjects. Dynamic topographic tests demonstrated abnormal scapulothoracic topographic patterns in 100% of individuals with impingement as compared to only 18% in asymptomatic subjects. Results of this study showed a significant difference in scapulothoracic topographic patterns between impingement and asymptomatic subjects.

Electromyographic (EMG) techniques have been utilized to study scapulothoracic function and position as it relates to glenohumeral dysfunction. Ryu et al[18] conducted a dynamic EMG analysis of the shoulder girdle muscles of uninjured tennis players and demonstrated that scapulothoracic muscles are active during glenohumeral motion. They concluded that fatigue of scapulothoracic muscles will negatively affect scapulothoracic-glenohumeral synchrony and will thus lead to abnormal biomechanics and to injury of surrounding tissues.

Clinical Techniques for Evaluating Scapular Position

Topographic and EMG techniques are costly, time-consuming, and unavailable for use in most physical therapy clinics. Variations on clinical methods utilized to measure scapular abduction have therefore been proposed. DiVeta et al[3] analyzed static scapular abduction by using two measurements. The first was total scapular distance, which is the distance from the spinous process of the third thoracic vertebrae to the inferior angle of the acromion. The second was scapular length, which is the distance between the root of the scapular spine and the inferior angle of the acromion. To obtain the scapular abduction measurement, total scapular distance was divided by scapular length. This method was found to have high intratester and intertester reliability.[3,14,19] Greenfield et al[19] reproduced this study and obtained similar results. To assess validity of this measurement method, x-rays of the shoulder girdle and thoracic spine were taken. The same landmarks used in the manual method were then measured on the x-rays. Researchers found no significant difference between measurements in the manual method and the X-ray method. Therefore, these results confirmed criterion validity of the manual method for assessing scapular position.

Kibler, MD[2] described the lateral scapular slide test (LSST), a quick and simple clinical evaluation tool to measure scapular stability. The LSST involves taking bilateral measurements between the medial scapular border and the corresponding spinous process in each of three positions of humeral abduction: 1) the arms at rest at the sides and in neutral rotation, 2) the hands placed on the hips with the thumbs pointing posteriorly, 3) the arms abducted to 90 degrees with maximal internal rotation. Dr. Kibler's research examined scapular position as it related to glenohumeral dysfunction in overhead throwing athletes. His research demonstrated that scapular position was very symmetrical in normal asymptomatic overhead athletes. He found a difference of greater than one centimeter bilaterally in either position 2 or 3 to correlate significantly with glenohumeral pain and dysfunction.[2]

Purpose

Clinical methods described by DiVeta et al[3] and Kibler[2] for evaluating scapular position have been utilized on a limited basis in the clinic and for research purposes. Validity, however, has not been well-established for these tests. For this reason, currently there are no clinically feasible screening tools which can be utilized to recognize and measure scapulothoracic instability. Therefore, the purpose of this study was to evaluate validity of such a screening tool, a modified version of the LSST.

The current study did not utilize position 3 of Kibler's LSST[2] (humerus in 90 degrees of abduction) for several reasons. Prior studies using the LSST have produced similar results in positions 2 and 3. As mentioned earlier, Kibler[2] found that bilateral differences in either position 2 or 3 were statistically significant. Johnson[20] and Davies et al[21] found no significant difference between position 1 and position 2 measurements with varying degrees of humeral abduction. Additionally, while studies have demonstrated high intertester reliability for position 1 and 2, this reliability has been greatly variable for position 3, rating from poor to good.[14,20,22] Furthermore, maintaining a position of 90 degrees of humeral abduction with maximal internal rotation is quite difficult and painful for subjects who are undergoing treatment for glenohumeral impingement.

CHAPTER III

METHODS

Subjects

Forty subjects between the ages of 20 and 76 consented to participate in the study. All subjects were patients at an outpatient physical therapy clinic in Spokane, Washington. Twenty subjects had no history of shoulder problems and were undergoing physical therapy for an unrelated problem. The remaining 20 subjects were receiving physical therapy for unilateral shoulder impingement. For the purpose of this study, shoulder impingement was defined as pain in the anterior glenohumeral region which could be reproduced through provocative tests such as the impingement test and impingement sign. Persons with spinal curvature, uneven iliac crests, or surgical reconstruction of either shoulder were excluded from this study as these abnormalities can alter measurements. All subjects read and signed a consent form approved by the Institutional Review Board at the University of North Dakota (Appendix A) prior to participation in the study.

Procedure

Subjects were individually measured by one of four licensed physical therapists within a physical therapy clinic. All therapists received standardized written and verbal instruction on administering the abbreviated LSST. A pilot study evaluating intratester and intertester reliability was performed on the testers prior to their inclusion in the study. Data collected from the pilot study was analyzed using an ANOVA. Intratester reliability was shown to be very good with alpha coefficients in positions 1 and 2 of .9993 and .9983 respectively. Intertester reliability of the pilot study was also very good with alpha coeffiecients of .9667 and .9472 in positions 1 and 2 respectively.

Data collection for the study was conducted during regularly scheduled physical therapy treatment times. All subjects were asked to answer four questions included on the standardized data collection sheet (Appendix B). Questions asked the subjects to describe pain and to list current activities involving the upper extremities. To obtain the data, the scapula and spine were completely visible to increase accuracy of measurements. Female subjects were draped in an open-back gown wearing no bra or halter, and male subjects were measured wearing no clothing over the upper body. The subjects were asked to stand and look straight ahead in a relaxed, erect position with the feet approximately shoulder-width apart. Bilateral measurements were taken in the following positions: 1) arms relaxed at the sides at zero degrees of humeral abduction (Fig 2); and 2) hands evenly positioned on the iliac crests with thumbs

Fig 2.--Test position 1 for the lateral scapular slide test

Fig 3.--Test position 2 for the lateral scapular slide test

pointing posteriorly, approximating 45 degrees of humeral abduction (Fig 3), for a total of four measurements. The apex of the distal-most point of the inferior scapular angle and the ipsilateral lateral border of the adjacent spinous process were palpated. Using an eight-inch ruler with millimeter markings, the tester measured the linear distance between these two points (Fig 4). All measurements were recorded to the nearest millimeter on the data collection sheet (Appendix B).

Data Analysis

The difference between corresponding right and left measurements for both positions was calculated for each subject and statistically analyzed using a t-test for independent samples. Levene's test for equality of variance was utilized to insure homogeneity of samples.[23]

Probability values (*p*) derived from the two-tailed t-test for Equality of Means were used to determine significance at the .05 level between the control and impingement group means. This was done for both test positions. A *p* value of less than .05 indicated a significant difference.

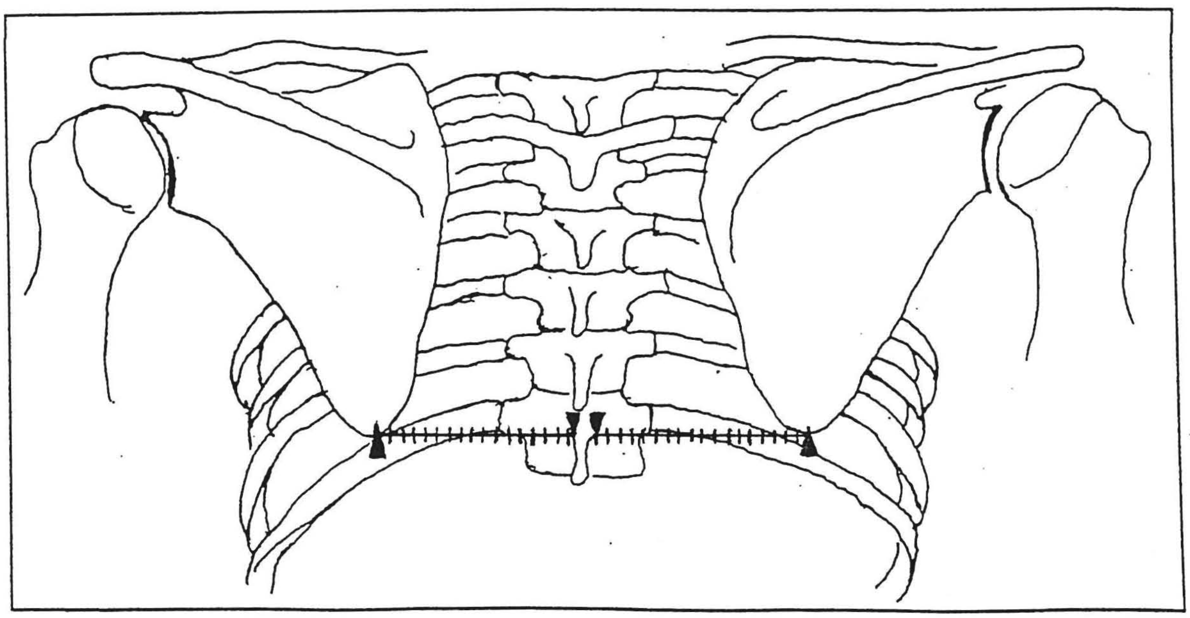

Fig 4.-- Measurement points for the lateral scapular slide test.

CHAPTER IV

RESULTS

Means, standard deviations, and probability values for each group and position are presented in Table 1. A significant difference in scapular symmetry was found between the impingement and asymptomatic groups for position 1 ($p < .05$). Scapular symmetry measurements were not significantly different between the impingement and asymptomatic groups for position 2 ($p > .05$). As sample variance was not equal between samples in position 1, the independent t-test for unequal means was employed in analyzing these statistics.[23]

Table 1. --Descriptive Statistics for Positions 1 and 2

Group	Position	N	Mean (cm)	SD	p
Control	1	20	0.5600	0.515	
Impingement	1	20	1.0025	0.782	.042*
Control	2	20	0.6100	0.598	
Impingement	2	20	0.9300	0.758	.147

* Significant difference, p< .05

CHAPTER V

DISCUSSION

Results of this study examining the modified Lateral Scapular Slide Test (LSST) demonstrate that there was a significant difference in scapular abduction measurements between subjects with glenohumeral impingement symptoms and subjects without impingement symptoms in position 1. No significant difference was found between impingement and asymptomatic groups for position 2. Results suggest that the modified lateral scapular slide test is valid for position 1, and can thus be utilized to predict subjects with unilateral shoulder impingement syndrome. The test was not found to be valid for position 2.

These results do not correlate with those of Kibler,[2] who found that in position 2, a difference greater than one centimeter between involved and uninvolved shoulders correlated significantly with glenohumeral pain and dysfunction. Results obtained for position 2 are in agreement with Greenfield et al,[19]who found no significant difference in scapular abduction between symptomatic and asymptomatic subjects using either the manual method described by DiVeta et al,[3] or the X-ray technique. However, Greenfield et al[19] included subjects with bilateral glenohumeral involvement in the pathology group. Including subjects with bilateral involvement in the study would likely affect validity since the described scapular tests compare right to left scapular measurements. Results obtained in position 2 also agree with Odom et al,[24] who were unable to predict subject group membership (impingement vs. uninvolved) from obtained measurements. These researchers found that the mean bilateral difference approximated one centimeter regardless of test position or group membership.

It is an interesting observation that scapular asymmetry between groups was significantly different in position 1 but not in position 2. Analysis of group scapular asymmetry mean values demonstrated that scapular asymmetry increased slightly from position 1 to position 2 in the control group, and decreased slightly from position 1 to position 2 in the impingement group. Thus, as shoulder elevation increased from 0 to 45 degrees, scapular asymmetry increased slightly in the normal population. Symmetry appeared to increase slightly in the impingement group. This seems paradoxical as 45 degrees of shoulder elevation typically increases demand on the scapular stabilizers due to a lengthened scapular moment arm. It is logical to conclude that muscle weakness should be accentuated in this elevated position, as evidenced by increased scapular abduction. It is postulated that increased scapular abduction was not detected in position 2 due to rehabilitation factors. Prior to testing, a majority of patients in the impingement group had performed scapular strengthening exercises. The number of treatment sessions a patient had received prior to test administration varied. Thus, it is very plausible that scapular strengthening and re-training had occurred to a certain degree in some, if not all persons in the impingement group. This is a weakness of the present study.

Further analysis of results revealed that in position 1 of the impingement group only nine out of 20 subjects (45%) demonstrated increased lateral scapular translation on the affected side. Of these nine subjects, seven fit Kibler's criteria for a positive LSST (increased lateral scapular translation of greater than one centimeter on the affected side). Thus, only seven of the 20 subjects in the impingement group (35%) demonstrated a positive LSST. Therefore, these findings raise significant question as to whether the LSST identifies the criteria on which it is based. As mentioned earlier, results of this study demonstrated a significant difference to exist in scapular asymmetry between impingement and control subjects in position 1. Therefore, research on larger populations of impingement subjects who have not yet engaged in scapular strengthening exercises is necessary to identify the specific factors causing this scapular asymmetry. Such research will help to confirm/disconfirm content validity of the LSST.

A criticism of the LSST is that it fails to account for variability in scapular size. Asymmetric scapular size relative to scapular width may influence test results.[3,19] As the modified LSST utilized in this study involves obtaining measurements from the inferior scapular angle to the corresponding spinous process, scapular length will not influence measurements. Anomalies in scapular size should be assessed prior to use of this tool, as a noticeable discrepancy in scapular width may invalidate use of the LSST.

It has been suggested that the LSST, an isometric test, is not a true indicator of functional scapulothoracic instability as described by Kibler.[2,4,14] The shoulder complex is highly dynamic, and functional scapular instability may not be apparent under static conditions which do not account for temporal lag or fatigue. Fatigue is an important factor when considering scapulothoracic instability, as fatigue may accentuate weakness of the scapular stabilizers. The LSST may not be sufficient for measuring dynamic scapulothoracic instability. However, if weakness is evident by a positive LSST, it is very likely that dynamic deficiencies may exist. Therefore, if static scapulothoracic weakness is demonstrated, it is very important that the clinician consider the scapulothoracic joint when outlining a treatment regimen for that particular patient.

It has been questioned whether resting scapular position changes with age or with anterior/posterior curvature of the thoracic spine. These factors may affect validity of the LSST. Recent research has demonstrated that scapular protraction and/or scapular symmetry are not significantly correlated with increasing kyphosis or spinal curvature.[11] Culham[11] examined the relationship of scapular position to spinal posture and age in 91 females between the ages of 20 and 85. Using an electromagnetic device, the researcher measured position of the shoulder complex in 3 planes. No change was found in lateral scapular translation measurements with increasing age or kyphosis. Evidence from this study suggests that LSST measurements will not be affected by spinal curvature in the sagittal plane.

It has been suggested that asymmetrical hypertrophy of scapulothoracic muscles, which is common in overhead athletes, may be normal and will affect measurement.[4] Gibson et al[14] evaluated the intratester and intertester reliability of the four previously described techniques for measuring scapular position (three positions described by Kibler and one by DiVeta). Measurements were then compared between dominant and nondominant extremities of 32 asymptomatic non-athletic subjects. A significant difference between right and left extremities was found by one tester in only one of the four measurement techniques. Thus, hypertrophy significantly affected only one of eight measurements of scapular position utilized in Gibson's study; all others were non-significant. Results may vary in athletic populations, however. The present study showed a trend for increased scapular measurement on the dominant side of control subjects. In positions 1 and 2, 12 out of 14 (86%) and 13 out of 14 (92%) subjects demonstrated increased lateral scapular translation on the dominant side. The remaining six subjects either demonstrated no difference or did not report a dominant extremity. Numbers were not subjected to statistical analysis, however. Further research using larger sample sizes of persons with asymptomatic shoulders is necessary to determine whether extremity dominance affects LSST measurements.

While intratester and intertester reliability of the LSST has been demonstrated,[20,22] a careful familiarization period is needed to assure this reliability. In the present study, two pilot tests were necessary before intertester reliability was sufficient. The first pilot test utilized cloth tape measures. Rigid eight-inch rulers were used in the second pilot study. Gibson et al,[14] whose research demonstrated low intertester reliability of the LSST, used string as the measurement tool. They suggest that it is difficult to achieve a consistent amount of "tautness" in the string. This may also be the case with cloth measuring tapes, and consequently will affect scapular slide measurements. It is unclear whether the use of rulers or the practice effect lead to the increased reliability in the second pilot study. It is also necessary to utilize standardized measurement points on the spinous process and inferior scapular angle. Johnson[20] states that standardization is key in assuring reliability. This is particularly important for the inferior scapular angle as it describes an arc rather than a discrete point. Ambiguous reference points will introduce error to the measurement and result in unreliable data.

CHAPTER VI

CONCLUSIONS

The current study examined validity of the modified LSST in predicting glenohumeral impingement. Results demonstrated a significant difference in scapular symmetry between impingement and asymptomatic groups for position 1, but not for position 2. Thus, position 1 of the modified LSST was found to be valid in detecting a significant difference in scapular symmetry between the impingement and control groups.

Because position 1 of this test was successful in detecting scapular asymmetry in subjects with impingement, results suggest that this test may be utilized in the clinic to assess scapulothoracic abnormalities in this patient population. Detecting scapulothoracic abnormality in patients with glenohumeral impingement is necessary to establish a proper treatment plan. The plan should include strengthening exercises for the scapular stabilizers, which are often overlooked in shoulder rehabilitation programs. If the scapular stabilizers are weak, beginning a strengthening program at the rotator cuff without first addressing the more proximal scapulothoracic muscles may lead to increased pain.[2] It is possible that position 1 of the LSST may be used to monitor progress of the patient and to decide when it is appropriate to add rotator cuff exercises.

Results of this study did not conclusively demonstrate content validity of the modified LSST. Evaluation of the data revealed that only 7 out of 20 subjects (35%) in the impingement group fit all of the criteria for a positive LSST described by Kibler. Further research on larger groups of impingement subjects who have not yet engaged in scapular strengthening exercises is needed to determine the factors causing scapular asymmetry. The range of scapular asymmetry considered normal in an asymptomatic population is also unclear. Future studies should attempt to identify normative values.

APPENDIX A

APPENDIX A
CONSENT FORM

You are being invited to participate in a research study conducted by Denise G. Litchfield, a graduate physical therapy student at the University of North Dakota. Grand Forks. The purpose of this study is to establish validity of the Lateral Scapular Slide Test (LSST). The results of this study will benefit patients and the physical therapy community by providing valuable information about a relatively new evaluation technique.

Each subject will be tested in an isolated environment. As the shoulder blade and spine need to be completely visible, female subjects will be properly draped in an open-back gown, wearing no bra or halter, and male subjects will be measured with no clothing over the upper body. The study will ask two requirements of you: to stand relaxed with your arms at your sides, and to place your hands on your hips. You will be asked to hold these positions for a few seconds while the examiner takes two measurements in each position. The study will take approximately one minute to complete.

Since the LSST is non-invasive and involves normal arm movements, no personal risks are anticipated. This physical examination technique is routinely used in the clinical setting.

Information from the study will be anonymously coded to ensure confidentiality, and you will not be personally identified in any publication containing the results of the study. Consent forms and results will be secured for a 2 year period by Sue Jeno, M.A.,P.T., Department of Physical Therapy, University of North Dakota (701) 777-2831.

Participation is entirely voluntary, and you have the right to withdraw consent and discontinue participation in the study at any time without prejudice to present or future care at the present facility. Feel free to contact me at any time if you have questions regarding the study. I can be reached at the University of North Dakota Physical Therapy Dept. (701) 777-2831. In the event that physical injury is incurred during this study, medical treatment will be available as it is to any member of the public. Payment for treatment is the responsibility of you or your third party payer.

I have read all of the above and willingly agree to participate in this study. I fully understand the requirements of this study and understand that I may contact Denise G. Litchfield if I have any questions.

____________________________________ ____________

(Signature of Participant) (Date)

____________________________________ ____________

(Signature of Investigator) (Date)

APPENDIX B

APPENDIX B

DATA COLLECTION SHEET

To be completed by the subject:

Please answer the following questions (where applicable)

1. What repetative or strenuous activities do you perform on a regular basis that requires use of your arms (athletics, job demands, household activities)? Please be specific

____

2. Are you currently experiencing shoulder pain? Yes No If yes, please answer question 3 & 4

3. When did you notice the onset of pain (# of weeks, months, years ago)?__________

4. On a scale of 1-10 with 10 being excruciating pain, where would you rate your pain level: (please circle)

a. At the current time:	1	2	3	4	5	6	7	8	9	10
b. The average on a daily basis:	1	2	3	4	5	6	7	8	9	10
c. Before your first P.T. visit:	1	2	3	4	5	6	7	8	9	10

To be completed by therapist: Therapist Number: __________ Diagnosis: __________

Subject Number:	MODALITIES currently being utilized in the patient's rehabilitation program:		
Age:	Iontophoresis	Electrical Stimulation: Pain	Strengthening
Gender: Male Female	Phonophoresis	Mobilizations	Heat
Affected shoulder: R L Control	UE Stretches	Cortisone Injection	Ultrasound
Dominant Side: R L	Isokinetic Strengthening	Ice	
	Exercise for: Rotator cuff	Scapular Stabilizers	General UE strengthening

Hypertorphy/Atrophy noted in affected shoulder? (Describe location) __________

DATA:

Arms at Sides (in cm.)		Hands on Hips (in cm.)	
R	L	R	L
____	____	____	____

APPENDIX C

APPENDIX C

IRB FORM

______EXPEDITED REVIEW REQUESTED UNDER ITEM ______ (NUMBER[S]) OF HHS REGULATIONS
______EXEMPT REVIEW REQUESTED UNDER ITEM _________ (NUMBER[S]) OF HHS REGULATIONS

UNIVERSITY OF NORTH DAKOTA
HUMAN SUBJECTS REVIEW FORM
FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED
PROJECTS INVOLVING HUMAN SUBJECTS

PRINCIPAL
INVESTIGATOR: Denise G. Litchfield TELEPHONE: (701) 795-5152
DATE: 4/6/95

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: 2312 6th Ave. N., Grand Forks, ND 58203

SCHOOL/COLLEGE: University of North Dakota DEPARTMENT: Physical Therapy PROPOSED PROJECT DATES: 5/1/95 - 3/20/95

PROJECT TITLE: The Lateral Scapular Slide Test: is it Valid in Persons with Glenohumeral Pathology?
FUNDING AGENCIES (IF APPLICABLE): ________

TYPE OF PROJECT:
_____ NEW PROJECT _____ CONTINUATION _____ RENEWAL _____ DISSERTATION OR THESIS RESEARCH
X STUDENT RESEARCH PROJECT

_____ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Sue Jeno, M.A., P.T.

INVOLVES A COOPERATING
PROPOSED PROJECT: _____ INVOLVES NEW DRUGS (IND) _____ INVOLVES NON-APPROVED USE OF DRUG
X INSTITUTION

IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S):
___ MINORS (<18 YEARS) ___ PREGNANT WOMEN ___ MENTALLY DISABLED ___ FETUSES
___ MENTALLY RETARDED ___ PRISONERS ___ ABORTUSES ___ UND STUDENTS (>18 YEARS)

IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE _______

1. **ABSTRACT:** (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS).

Recent literature has focused on instability of the scapulothoracic joint and on scapular positions which occur as a result of this instability. Weakness of the scapular musculature can allow the scapula to slide laterally, leading to abnormal glenohumeral biomechanics and to subsequent shoulder pathology[1]. Kibler[1] has described the lateral scapular slide test (LSST) in which bilateral measurements are taken between the inferior angle of the scapula and the spinous process of the nearest vertebrae. A significant difference, a difference of greater than 1 cm side-to-side, may indicate functional scapulothoracic instability. Validity of this test has yet to be firmly established. Thus, the purpose of this study is to evaluate validity of the LSST in persons with glenohumeral pathology. Eighty subjects between the ages of 18-45, including 40 subjects who have not experienced shoulder impingement symptoms and 40 who have been diagnosed with shoulder pathology and who have experienced impingement symptoms within the last 3 months, will be individually evaluated by a licensed physical therapist using the LSST described by Kibler. Results will be analyzed using a t-test for independent samples. The use of human subjects is necessary because results are directly applicable to patient rehabilitation.

PLEASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

2. **PROTOCOL:** (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

Subjects: The subject pool will consist of a maximum of eighty subjects between the ages of 18-45, up to 40 who have been clinically diagnosed with unilateral shoulder pathology and who have experienced impingement symptoms within the last 3 months, and up to 40 who have experienced no shoulder problems. Persons who have received surgical reconstruction of either shoulder, or who have been diagnosed with spinal curvature, will be excluded as either of these could alter measurements for reasons unrelated to the study. The subjects will be voluntarily recruited at their consent from physical therapy clinics in Spokane, Washington. Permission to conduct data collection has been obtained from the owner of 10 private P.T. clinics in Spokane (see attached letter).

Materials: The LSST as described by Kibler,[1] a tape measure with millimeter markings, and a data form (Appendix A) will be utilized.

Procedure: Subjects will be individually measured in a private setting within a physical therapy clinic. The linear distance will be measured between the medial margin of both the right and left inferior scapular angles and the lateral border of the spinous process of the closest vertebral body. Bilateral measurements will be taken in each position, 1) with the subjects relaxed and arms at the sides, and 2) with the hands on the iliac crests, thumbs pointing posteriorly, for a total of 4 measurements. All measurements will be recorded to the nearest millimeter. A difference of greater than 1 cm between sides has been considered significant, as this difference has been demonstrated to correlate directly with pain symptoms.[1] The measurements will be recorded on a standardized data sheet. The data sheet will also include four short questions asking the subjects to describe pain and current activities involving the upper extremities. Data collection will be complete over a time period of 2 1/2 months.

Data Analysis: The difference in measurement scores between right and left sides will be calculated and recorded. These difference scores will then be statistically analyzed using the t-test for independent samples.

References:
Kibler WB. Role of the scapula in the overhead throwing motion. Contemp Orthop. 1991;22:525-532.

3. **BENEFITS:** (Describe the benefits to the individual or society.)

The results of this study will directly benefit the patient and physical therapy community by establishing the validity of the LSST for this population. The LSST is a quick and non-invasive evaluative technique which, if demonstrated valid, can be an effective clinical tool utilized to recognize scapulothoracic instability underlying glenohumeral pathology. Such information is valuable to the therapist in planning rehabilitation strategies for the patient.

4. **RISKS:** (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psycho-logical, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

The risks to the subjects are very minimal. The LSST is a quick and non-invasive technique in which the only requirements of the patients are to stand still with their arms at their sides, and to put their hands on their hips. Testing procedures will be performed in a private manner. Information from the study will be anonymously coded to ensure confidentiality.

5. **CONSENT FORM:** A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur. Describe where signed consent forms will be kept and for what period of time.

Consent forms and results will be secured for a 2 year period by Sue Jeno, M.A., P.T., Department of Physical Therapy, University of North Dakota (701) 777-2831. See Appendix B for a copy of the consent form.

6. For **FULL IRB REVIEW** forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development
University of North Dakota
Box 8138, University Station
Grand Forks, North Dakota 58202

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

- -

The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

SIGNATURES:

____ **DATE:** __________________

Principal Investigator

____ **DATE:** __________________

Project Director or Student Adviser

____ **DATE:** __________________

Training or Center Grant Director

(Revised 8/1992)

Spokane *Sports & Orthopedic Therapy*

26 April 1995

Institution Review Board
Office of Research and Program Development
University of North Dakota
Grand Forks, ND. 58203

RE: Acceptance of Research project at clinical site: **Denise Litchfield - Department of Physical Therapy**

To whom it may concern:

After an evaluation of the research proposal set forth by Ms. Litchfield, I would be honored to offer the services of our ten clinical sites to assist in this project. I do not foresee any potential problems that could arise nor will any patient be placed at risk. If you have any questions, please feel free to call.

Sincerely,

Gary J. Smith, PhD, PT, OCS, CMT
President, Spokane Sports and Orthopedic Therapy

A member of the Eagle Rehab family of clinics

12 East 5th Avenue, Suite 101, Spokane, WA 99202 **tel** 509-456-6560 **fax** 509-456-0653

UNIVERSITY OF NORTH DAKOTA'S
INSTITUTIONAL REVIEW BOARD

DATE: 5/2/95 **PROJECT NUMBER** IRB-9505-282

NAME: Denise G. Litchfield **DEPARTMENT/COLLEGE** Physical Therapy

PROJECT TITLE: The Lateral Scapular Slide Test: Is It Valid in Persons With Glenohumeral Pathology?

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on 5/9/95 and the following action was taken:

☑ Project approved. **EXPEDITED REVIEW** NO. 3.
Next scheduled review is on May 1996.

☐ Project approved. **EXEMPT CATEGORY** NO. _____. No periodic review scheduled unless so stated in REMARKS SECTION.

☐ Project approved **PENDING** receipt of corrections/additions in ORPD and approval by the IRB. **This study may NOT be started UNTIL IRB approval has been received.** (See REMARKS SECTION for further information.)

☐ Project approval **deferred. This study may not be started until IRB approval has been received.** (See REMARKS SECTION for further information.)

☐ Project **denied.**
(See REMARKS SECTION for further information.)

REMARKS: Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairman or ORPD.

for Cooley mc 5/9/95

Signature of ~~Chairperson~~ or designated IRB Member Date
UND's Institutional Review Board

: S. Jeno, Adviser
Dean, Medical School

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 596 Form may be required. Contact ORPD to obtain the required documents. (7/93)

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